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(54) **Electrostatic ink jet recording apparatus**

Elektrostatische Tintenstrahlaufzeichnungsvorrichtung

Imprimante électrostatique par jet d'encre

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- **PATENT ABSTRACTS OF JAPAN vol. 14, no. 416 (M-1021), 7 September 1990 & JP 02 160557 A (Y. SATOSHI), 20 June 1990,**

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an electrostatic ink jet recording head which accomplishes recording to a recording medium by using charged particulate materials in ink, and more particularly to an electrostatic ink jet recording apparatus which prevents precipitation of charged particulate material in ink.

Description of the Prior Art

[0002] An electrostatic ink jet recording apparatus according to the prior art, as disclosed in PCT Publication number WO 93/11866, has an electrostatic ink jet recording head and a counter electrode arranged behind recording paper. The counter electrode is provided for generating an electric field between the recording paper and the ink jet recording head. The ink jet recording head has an ink chamber for temporarily storing ink liquid supplied from an ink tank or the like. An ejection electrode is formed at an end of the ink chamber and driven when the ink is ejected. The tip of that ejection electrode is opposite to the counter electrode. The ink liquid in the ink chamber is fed by its own surface tension to the tip of the ejection electrode, where an ink meniscus is thereby formed.

[0003] The ink liquid used with that ink jet recording head contains charged particulate material for coloring. While the charged particulate material is electrified in a positive polarity by a Zeta potential, the ink liquid maintains electric neutrality when no voltage is fed to the ejection electrode. The polarity of the Zeta potential is determined by the characteristic of the charged particulate material.

[0004] When a voltage of the positive polarity is fed to the ejection electrode, the positive potential of the ink liquid is enhanced. The charged particulate material is caused by an electric field working between the ejection electrode and the counter electrode to shift in the ink liquid toward the tip of the ejection electrode. The charged particulate material having reached the tip of the ejection electrode is strongly drawn toward the counter electrode by the electric field working between the tip of the ejection electrode and the counter electrode. When the Coulomb force between the charged particulate material at the tip of the ejection electrode and the counter electrode substantially surpasses the surface tension of the ink liquid, an agglomeration of the charged particulate material accompanied by a small quantity of liquid flies from the tip position of the ejection electrode toward the counter electrode, and adhere to the surface of the recording medium. As the agglomeration of the charged particulate material is caused by the application of a voltage to the ejection electrode to successively fly from the tip of the ejection electrode, printing is accomplished.

[0005] However, the charged particulate material of the ink liquid used in the electrostatic ink jet recording head is readily precipitated by gravity, and therefore does not distribute evenly in the ink chamber. As a consequence, charged particulates are not steadily supplied to the tip of the ejection electrode, and the quantity of the charged particulate material in the agglomeration flying from the ink ejecting position is inconstant. Accordingly, there is the problem of difficulty to accomplish steady printing.

[0006] Furthermore, when the ink liquid in the ink chamber is to be shifted toward the tip of the ejection electrode only by the ejection electrode and the counter electrode, precipitation of the charged particulate material extends the shifting time, making it difficult to achieve high-speed printing.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is to eliminate the aforementioned disadvantages of the prior art, and in particular to provide an electrostatic ink jet recording apparatus capable of printing steady images.

[0008] Another object of the invention is to provide an electrostatic ink jet recording apparatus capable of high-speed printing.

[0009] According to the invention, there is provided an electrostatic ink jet recording apparatus comprising a head body and a counter electrode. The head body has an ink chamber for holding ink liquid containing charged particulate material. An ejection port is provided at one end of the head body and connected to the ink chamber. An ejection electrode is arranged near the ejection port and fed with an ejection voltage of the same polarity as the charge characteristic of the charged particulate material. The counter electrode is arranged opposite to the ejection port via a recording medium and has a necessary electric potential for electric attraction of the charged particulate material. A pair of vertically spaced stirring electrodes is arranged at the top and the bottom of the ink chamber and fed with a stirring voltage for shifting the charged particulate material at least in the direction reverse to the direction of gravity. A voltage generating circuit is provided for generating the ejection voltage and the stirring voltage, the latter being generated before the generation of the ejection voltage.

[0010] According to the invention, the stirring voltage for generating an electric field to shift the charged particulate material in the direction reverse to that of gravity is fed to the stirring electrodes. Moreover, that stirring voltage is generated earlier than the ejection voltage. As a result, the precipitation of toner particulates is prevented before the ejection of ink, and the overall concentration of toner particulars in the ink liquid in the ink chamber is uniformized. It is thereby made possible to supply a constant quantity of toner particulates to the tip

electrode section of the ejection electrode and accordingly to achieve high-quality prints free from irregularity of recording.

[0011] When one of the stirring electrodes comes into contact with the ink liquid, the electric potential of the ink liquid can be controlled so as to reach a sufficient level for the accomplishment of ejection, enabling the charge characteristic of the charged particulate material to be fully drawn upon. In this instance, the polarity of the D.C. voltage of the stirring electrode in contact with the ink liquid (stirring offset voltage) is made identical to the charge polarity of the charged particulate material.

[0012] Furthermore, when a stirring A.C. voltage is fed to the stirring electrodes besides the stirring offset voltage, the toner particulates can be stirred vigorously and quickly by the action of the alternating electric field.

[0013] In addition, the stirring electrodes, if they function when no pulse voltage is fed to the ejection electrode, not only are prevented from giving any deverse effect on ejection, but also can stabilize the quantity of toner particulates in the agglomerations, irrespective of the image to be recorded, by stirring consecutively during printing, and can thereby give prints of high quality.

[0014] There are two stirring electrodes: a first stirring electrode arranged at the bottom of the ink chamber and provided with the stirring the offset voltage, and a second stirring electrode arranged at the top thereof. Here, if the first stirring electrode is arranged also in a direction reverse to the direction of ink ejection, the charged particulate material can be shifted not only in the direction reverse to the direction of gravity but also in the direction of ink ejection. This arrangement enables the charged particulate material to be rapidly shifted in the direction of ink ejection.

[0015] Furthermore, the electrostatic ink jet recording apparatus according to the present invention may have an electrophoretic electrode apart from the stirring electrodes. To the electrophoretic electrode is supplied an electrophoretic voltage for shifting the charged particulate material toward the ejection hole by electrophoresis. In this case, the stirring voltage is generated before the generation of the electrophoretic voltage and of the ejection voltage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a plan of an electrostatic ink jet recording apparatus, which is a first preferred embodiment of the present invention, partly shown cross-sectionally;

FIG. 2 shows a cross section on the X-X line in FIG. 1;

FIG. 3 illustrates the drive circuit for the ink jet recording head for the electrostatic ink jet recording apparatus of FIG. 1;

FIG. 4 shows an expanded cross-sectional view of a state in which toner particulates have precipitated in the ink chamber;

FIG. 5 shows a cross-sectional view of the state of toner particulates in the ink chamber when a voltage is applied to the stirring electrodes;

FIG. 6 is a timing chart illustrating the operation of the drive circuit of FIG. 3;

FIG. 7 is a waveform diagram illustrating in a continuous form the stirring voltage shown in FIG. 6;

FIG. 8 is a plan of an electrostatic ink jet recording apparatus, which is a second preferred embodiment of the invention, partly shown cross-sectionally;

FIG. 9 shows a cross section on the Y-Y line in FIG. 8;

FIG. 10A is a plan of an electrostatic ink jet recording apparatus, which is an alternative version of the second preferred embodiment of the invention, partly shown cross-sectionally;

FIG. 10B shows a profile of the electrostatic ink jet recording apparatus of FIG. 10A; and

FIG. 11 shows a cross section on the Z-Z line in FIG. 10A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] In FIGS. 1 and 2, the ink jet recording apparatus has an electrostatic ink jet recording head 10 and a counter electrode 20 arranged at a prescribed distance from the ink jet recording head 10. On the surface of the counter electrode 20 is arranged a recording medium P, which is carried by a carrying mechanism (not shown) in the direction of arrow S in FIG. 2. The counter electrode 20, consisting of an electroconductive body, is grounded so as to give its surface a potential of 0 V.

[0018] The ink jet recording head 10 has a head body 1, an ejection electrode 2, an electrophoretic electrode 4, stirring electrodes 5A and 5B, an ink inlet 6 for feeding ink liquid, and an ink chamber 8 for storing the ink liquid. The ink liquid fed to the ink chamber 8 consists of charged particulate material (toner particulates) of thermoplastic resin, colored together with a charge control agent, dispersed in a petroleum-derived organic solvent (iosparaffin). The toner particulates are charged in an apparent positive polarity by a zeta potential. The ink inlet 6, connected to an ink tank (not shown) by a tube, feeds ink liquid into the ink chamber 8. In this process, a negative pressure of about 1 cm H_2O is given to the ink liquid, which is thereby subjected to forced circulation.

[0019] The head body 1 consists of a dielectric substance, and the ink chamber 8 is formed within it. At the end of the ink chamber 8 in the ink ejecting direction is formed an ejection port, that is a minute ejection hole 3, from which part of the ink liquid is ejected. The ink chamber 8 is formed so that the cross-sectional area of its space gradually diminishes toward the ejection hole 3,

underneath which is arranged the ejection electrode 2.

[0020] The ejection electrode 2 extends upward from the bottom face of the head body 1, and its tip electrode section 2A extends toward the ejection hole 3. The tip of the tip electrode section 2A is sharpened to facilitate concentration of the electric field. Above the tip electrode section 2A is formed an insulating film 7, which is a protective film to prevent the ink liquid from coming into contact with the tip electrode section 2A.

[0021] The electrophoretic electrode 4 is formed by the rear face, reverse to the ink ejecting direction, and two side faces of the head body 1. The electrophoretic electrode 4 is fed with an electrophoretic voltage having the same polarity as the charge polarity of the toner particulates in the ink liquid. This electrophoretic voltage generates a phenomenon of electrophoresis in which the toner particulates in the ink liquid fed from the ink inlet 6 shift toward the counter electrode 20, i.e. the ejection hole 3. As the cross-sectional area of the space in the ink chamber 8 diminishes toward the ejection hole 3, the density of the toner particulates increases as they move toward the ejection hole 3.

[0022] The stirring electrodes 5A and 5B are formed respectively at the top and at the bottom of the ink chamber 8, and connected to a stirring voltage generating circuit 9. The stirring electrode 5A is formed over the ink chamber 8 reverse to its gravity direction. An insulating layer 70 covers the stirring electrode 5A so that the electrode 5A does not come into contact with the ink liquid. The stirring electrode 5B, positioned under the ink chamber 8, is formed so as to come into contact with the ink liquid. The stirring voltage generating circuit 9, having a D.C. offset power source 9A for generating a stirring offset voltage and an A.C. power source 9B for supplying a stirring A.C. voltage, generates a voltage in which the stirring A.C. voltage is superposed over the stirring offset voltage, and feeds it between the stirring electrodes. The stirring offset voltage has the same polarity as the charge polarity of the toner particulates. The connection of the positive pole side of the stirring offset voltage to the stirring electrode 5B causes the electric field generated by the stirring offset voltage to be directed reverse to the gravity direction. This causes the positively polarized toner particulates having accumulated at the bottom of the ink chamber 2 to shift in the direction of the electric field. The stirring A.C. voltage supplied at the same time as the stirring offset voltage contributes to more efficient stirring of the toner particulates. Here, if the charge polarity of the toner particulates is reverse, this can be corrected by reversing the relationship between the positive and negative poles of the stirring offset power source 9A.

[0023] FIG. 3 illustrates the configuration of the circuit to drive the ejection electrode 2, electrophoretic electrode 4 and stirring electrodes 5A and 5B. Referring to the diagram, a control circuit 30 controls an electrophoretic voltage generating circuit 31, an ejection voltage generating circuit 32 and the stirring voltage generating circuit 9 on the basis of print data. The electrophoretic voltage generating circuit 31 generates the electrophoretic voltage to drive the electrophoretic electrode 4. The ejection voltage generating circuit 32 generates the ejection voltage to drive the ejection electorde 2. The stirring voltage generating circuit 9, as shown in FIG. 2, has the stirring offset power source 9A and the A.C. power source 9B. The electrophoretic voltage may be, for instance, 2 kV, the ejection voltage, 1 kV, and the stirring offset voltage from the D.C. offset power source 9A, 500 V, and the amplitude of the stirring A.C. voltage from the A.C. power source 9B may be 1 kV. These voltages are determined by the charge characteristic of toner particles, the distance between the ink jet recording head 10 and the counter electrode 20, and the structures of the various electrodes, but not confined to the above-stated values. The frequency of the stirring A.C. voltage from the A.C. voltage 9B, which determines the period of stirring, may be set to the experimentally optimal value.

[0024] The control circuit 30, after the start-up of the apparatus, controls the stirring voltage generating circuit 9 and the electrophoretic voltage generating circuit 31 so that the stirring voltage be fed to the stirring electrodes 5A and 5B before the electrophoretic voltage is applied to the electrophoretic electrode 4. It also controls the stirring voltage generating circuit 9 so that the stirring voltage be generated when no ejection voltage is fed to the ejection electrode in accordance with print data.

[0025] Next will be described the printing operation. When the electrophoretic voltage is fed to the electrophoretic electrode 4, an electric field is formed between the electrophoretic electrode 4 and the counter electrode 20, and electrophoresis causes toner particulates to shift toward and concentrate in the ejection hole 3. Then, when a voltage pulse is applied to the ejection electrode 2, an electric field is formed between the tip electrode section 2A of the ejection electrode 2 and the counter electrode 20, and the agglomerations of toner particulates having concentrated in the ejection hole 3 fly from there toward the counter electrode 20. The agglomerations of toner particulates which have flown adhere to the recording medium P. On the other hand, the toner particulates which have been reduced in the vicinity of the ejection hole 3 by the ejection are again shifted by electrophoresis attributable to the electrophoretic voltage toward the ejection hole 3 to be readied for consecutive ejection. Repetition of these actions causes a toner image to be formed on the recording medium P that is carried. The recording medium P on which the toner image has been formed is carried to a fixed (not shown) and thermally fixed.

[0026] Hereupon, as the toner particulates have a greater specific gravity than the ink solvent, if they are allowed to stand for a long period of time, the toner particulates T precipitate in the ink chamber 8 as illustrated in FIG. 4. During printing, as the electrophoretic elec-

trode 4 electrophoreses the toner particulates T to bring them together in the vicinity of the ejection electrode 2, the concentration of the toner particulates T becomes uneven in the ink chamber 8. Furthermore, since the consumption of the toner particulates T is not necessarily constant but varies with the image to be printed, the concentration of the toner particulates in the vicinity of the ejection electrode 2 is inconstant. In such a case, the toner particulates are not supplied in a uniform volume to the vicinity of the ejection electrode 2, resulting in the disadvantage that the volume of ejected toner varies with the recorded image and the printed image becomes uneven.

[0027] In view of this problem, in this preferred embodiment of the invention, the stirring voltage generating circuit 9 feeds the stirring voltage to the stirring electrodes 5A and 5B before the electrophoretic voltage is applied to the electrophoretic electrode 4, as shown in FIG. 6. The stirring voltage, as shown in FIG. 7, consists of the stirring A.C. voltage, 1 kV on a peak-to-peak basis, superposed over the stirring offset voltage, 500 V. This causes an alternating electric field in the gravity direction to be formed in the ink chamber 8, and the toner particulates T which have precipitated therein soar as illustrated in FIG. 5. To describe this stirring action in more detail, the toner particulates T are shifted in the direction reverse to the gravity direction by the stirring offset voltage fed from the D.C. offset power source 9A in FIGS. 2 and 3 to the stirring electrodes 5A and 5B. Simultaneously with the stirring offset voltage, the stirring A.C. voltage is applied, and the toner particulates T rapidly shift contrary to the gravity direction while the A.C. voltage is high and in the gravity direction while the A.C. voltage is low (while its polarity is reverse). This process efficiently stirs the toner particulates T having precipitated and accumulated in the ink chamber 8, and their concentration is generally uniformized, too. After the application of this stirring voltage, the electrophoretic voltage is fed to the electrophoretic electrode 4, and the resultant electrophoresis shifts the toner particulates T in the direction of ink ejection and, after that, the ejection voltage causes the agglomerations of ink particulates to fly from the ejection hole 3.

[0028] As shown in FIG. 6, when printing is to be done, although the stirring voltage, electrophoretic voltage and ejection voltage generate in that order, the electrophoretic voltage may be supplied to the electrophoretic electrode 4 while the ejection voltage is being supplied to the ejection electrode 2. Further, if the stirring voltage is generated earlier than the electrophoretic voltage, the generating period of the electrophoretic voltage and that of the stirring voltage may partly overlap each other.

[0029] As so far described, in this preferred embodiment of the invention, the stirring electrodes 5A and 5B are fed with the stirring voltage to generate an electric field which has the same polarity as the toner particulates and shifts them contrary to the gravity direction. As a result, the toner particulates are prevented from precipitating, and their concentration in the ink liquid in the ink chamber is generally uniformized. This enables a uniform quantity of toner particulates to be supplied to the tip electrode section 2A of the ejection electrode 2, resulting in high-quality prints with no irregularity of recording. As the stirring electrodes 5A and 5B are also fed with the stirring A.C. voltage in addition to the stirring offset voltage, the toner particulates can be vigorously and rapidly stirred by the action of the resultant alternating electric field.

[0030] Moreover, as the stirring electrodes 5A and 5B function when no pulse voltage is applied to the ejection electrode, they not only have no adverse effect on the ejecting action but also consecutively perform stirring during the printing process. This serves to stabilize the quantity of toner particulates in the agglomerations irrespective of the image to be recorded, and enables high-quality prints to be obtained.

[0031] Furthermore, since the stirring voltage is generated before the application of the electrophoretic voltage to the electrophoretic electrode 4, the toner particulates are dispersed by the stirring, and the dispersed toner particulates can be quickly carried by electrophoresis to the ejection hole 3. It is thereby made possible to carry the right amount of toner particulates to the ejection hole 3 more smoothly than when they have precipitated, restrain unevenness of ejection, realize high print quality, and accomplish steady high-speed printing by the continuous ejection of toner particulates.

[0032] In the electrostatic ink jet recording apparatus illustrated in FIGS. 8 and 9, which is a second preferred embodiment of the present invention, an ink jet recording head 100 dispenses with the electrophoretic electrode 4 of the ink jet recording head 10 of FIGS. 1 and 2, and a stirring electrode 15B extends to a position opposite to the ejection hole 3. A stirring electrode 15A, arranged in a position vertically opposite to the stirring electrode 15B, is formed from the ink inlet 6 to the vicinity of the ejection hole 3. A stirring electrode generating circuit 19 has a stirring offset power source 19A, and a stirring A.C. power source is dispensed with. In other respects, this embodiment has the same configuration as the above-described first embodiment.

[0033] As a stirring offset voltage, 1 kV, is fed to the stirring electrodes 15A and 15B, the toner particulates which have precipitated therein soar, the dispersed in the ink and uniformized. Since the stirring electrode 15B is formed not only on the bottom side of the ink chamber 8 but also on the face opposite to the ejection hole 3, the toner particulates in the vicinity of the ink inlet 6 shift toward the ejection hole 3 and the stirring electrode 15A. Accordingly, the stirring electrode 15B performs both the role of the stirring electrode 5B in FIG. 1 and that of the electrophoretic electrode to shift the toner particulates in the direction of ink ejection.

[0034] Thus, the ink jet recording head 100 can not only realize dispersion and uniformization of toner particulates and high-speed printing as does the ink jet re-

cording head 10 of the first embodiment, but also can be reduced in cost commensurately with the absence of the electrophoretic voltage generating circuit and the A. C. power source for stirring.

[0035] The present invention is not limited to the preferred embodiments described above. For instance, the shapes of the ink chamber 8 and the ejection hole 3 are not confined to those used in the first and second embodiments. As illustrated in FIGS. 10A and 10B, an ink jet recording head 200 may have a plurality of ejection holes 23 arranged at regular intervals with partitions 24 in-between. In an ink chamber 80, unlike the ink chamber 8 in FIG. 1, the cross-sectional area of the space within does not shrink toward the ejection holes. As shown in FIG. 11, the face of the ink chamber 80 opposite to the ejection holes 23 is formed in a flat or curved shape, slanted with respect to the gravity direction. This makes it difficult for toner particulates in the ink liquid to accumulate in the vicinity of the ink inlet.

[0036] On the bottom of the ink chamber 80 is formed an insulating film 40, underneath which is formed a stirring electrode 25B. The stirring electrode 25B and the insulating film 40 are formed from the ink inlet 6 to the vicinity of the ejection electrode 2. As the insulating film 40 simultanesouly insulates the ejection electrode 2 and the stirring electrode 5B from the ink liquid, there is the advantage of simplifying the manufacturing process. When the stirring offset voltage is fed to the stirring electrodes 25A and 25B, toner particulates having precipitated and accumulated on the bottom of the ink chamber 8 soar, and are dispersed in the ink and uniformized. As the stirring electrode 25B is formed not only on the bottom side of the ink chamber 8 bit also on its face opposite to the ejection holes 23, the toner particulates in the vicinity of the ink inlet 6 shift toward the plurality of ejection holes 23 and the stirring electrode 25A. Therefore, the stirring electrode 25 plays both the role of the stirring electrode 5B and that of the electrophoretic electrode in FIG. 1.

Claims

1. An electrostatic ink jet recording apparatus comprising:

   a head body (1) having an ink chamber (8 or 80) for holding ink liquid containing charged particulate material;
   an ejection port (3 or 23), provided at one end of said head body and connected to said ink chamber, for ejecting the ink liquid;
   an ejection electrode (2) arranged near said ejection port and fed with an ejection voltage of the same polarity as the charge characteristic of said charged particulate material; and
   a counter electrode (20) arranged opposite to said ejection port via a recording medium and having a necessary electric potential for electric attraction of said charged particulate material;

   characterized by a pair of vertically spaced stirring electrodes (5A, 5B or 15A, 15B or 25A, 25B) arranged at the top and at the bottom of said ink chamber and fed with a stirring voltage for shifting said charged particulate material at least in the direction reverse to the direction of gravity; and
   voltage generating means (30, 31, 32 and 9 or 19) for generating said ejection voltage and said stirring voltage, the latter being generated before the generation of said ejection voltage.

2. An electrostatic ink jet recording apparatus, as claimed in Claim 1, wherein said voltage generating means includes ejection voltage generating means (32) for generating said ejection voltage and stirring voltage generating means (9 or 19) for generating said stirring voltage; one of said stirring electrodes is in contact with said ink liquid; and said stirring voltage generating means (9 or 19) generates as said stirring voltage a D.C. voltage having the same polarity as said charged particulate material.

3. An electrostatic ink jet recording apparatus, as claimed in Claim 2, wherein said stirring voltage generating means (9) generates a stirring voltage consisting of said D.C. voltage over which an A.C. voltage is superposed.

4. An electrostatic ink jet recording apparatus, as claimed in Claim 2, wherein said stirring voltage is generated when said ejection voltage is not generated.

5. An electrostatic ink jet recording apparatus, as claimed in Claim 1, wherein said stirring electrodes comprise a first stirring electrode (15B or 25B) arranged at the bottom of said ink chamber and a second stirring electrode (15A or 25A) arranged at the top thereof; and said first stirring electrode is arranged also on the side opposite to said ink ejecting direction, and is fed with a stirring voltage for shifting said charged particulate material in the direction reverse to the direction of gravity and in said ink ejecting direction.

6. An electrostatic ink jet recording apparatus, as claimed in Claim 5, wherein the face of said ink chamber (80) opposite to said ejecting port (23) is inclined with respect to the direction of gravity.

7. An electrostatic ink jet recording apparatus, as claimed in Claim 1, wherein:

   an electrophoretic electrode (4) to which an electrophoretic voltage is supplied to shift said

charged particulate material to said ejecting port by electrophoresis is formed in said head body; and

said generating means generates said ejection voltage, said electrophoretic voltage and said stirring voltage, and said stirring voltage is generated before the generation of said electrophoretic voltage and said ejection voltage.

8. An electrostatic ink jet recording apparatus, as claimed in Claim 7, wherein said stirring voltage is a D.C. voltage having the same polarity as said charged particulate material.

9. An electrostatic ink jet recording apparatus, as claimed in Claim 8, wherein said stirring voltage consists of said D.C. voltage over which an A.C. voltage is superposed.

Patentansprüche

1. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung mit

einem Kopf-Körper (1) mit einer Tintenkammer (8 oder 80) zum Halten von Tintenflüssigkeit, die geladene Partikel enthält,

einer Ausstoßöffnung (3 oder 23), die an einem Ende des Kopf-Körpers vorgesehen und mit der Tintenkammer verbunden ist, zum Ausstoßen der Tintenflüssigkeit,

einer Ausstoßelektrode (2), die in der Nähe der Ausstoßöffnung angeordnet ist und mit einer Ausstoßspannung mit der gleichen Polarität wie der Ladungskennwert der geladenen Partikel gespeist wird, und

einer Gegenelektrode (20), die der Ausstoßöffnung über ein Aufzeichnungsmedium gegenüberliegend angeordnet ist und ein nötiges elektrisches Potential für elektrische Anziehung der geladenen Partikel hat,

gekennzeichnet durch ein Paar vertikal beabstandete Rührelektroden (5A, 5B oder 15A, 15B oder 25A, 25B), die an der Oberseite und an der Unterseite der Tintenkammer angeordnet sind und mit einer Rührspannung zum Verlagern der geladenen Partikel zumindest in der Richtung umgekehrt zur Richtung der Schwerkraft gespeist werden, und

eine Spannungserzeugungseinrichtung (30, 31, 32 und 9 oder 19) zum Erzeugen der Ausstoßspannung und der Rührspannung, wobei die Letztere vor der Erzeugung der Ausstoßspannung erzeugt wird.

2. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 1 beansprucht, bei der die Spannungserzeugungseinrichtung eine Ausstoßspannungs-Erzeugungseinrichtung (32) zum Erzeugen der Ausstoßspannung und eine Rührspannungs-Erzeugungseinrichtung (9 oder 19) zum Erzeugen der Rührspannung enthält, eine der Rührelektroden mit der Tintenflüssigkeit in Kontakt ist und die Rührspannungs-Erzeugungseinrichtung (9 oder 19) als die Rührspannung eine Gleichspannung mit der gleichen Polarität wie die geladenen Partikel erzeugt.

3. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 2 beansprucht, bei der die Rührspannungs-Erzeugungseinrichtung (9) eine Rührspannung erzeugt, die aus der Gleichspannung besteht, der eine Wechselspannung überlagert ist.

4. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 2 beansprucht, bei der die Rührspannung erzeugt wird, wenn die Ausstoßspannung nicht erzeugt wird.

5. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 1 beansprucht, bei der die Rührelektroden eine erste, an der Unterseite der Tintenkammer angeordnete Rührelektrode (15B oder 25B) und eine zweite, an deren Oberseite angeordnete Rührelektrode (15A oder 25A) umfassen, und bei der die erste Rührelektrode außerdem auf der der Tintenausstoßrichtung entgegengesetzten Seite angeordnet ist und mit einer Rührspannung zum Verlagern der geladenen Partikel in der Richtung umgekehrt zur Richtung der Schwerkraft und in der Tintenausstoßrichtung gespeist wird.

6. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 5 beansprucht, bei der die der Ausstoßöffnung (23) entgegengesetzte Seite der Tintenkammer (80) in Bezug auf die Richtung der Schwerkraft geneigt ist.

7. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 1 beansprucht, bei der:

eine Elektrophoreseelektrode (4), der eine Elektrophoresespannung zugeführt wird, um die geladenen Partikel durch Elektrophorese nach der Ausstoßöffnung zu verlagern, in dem Kopf-Körper gebildet ist, und

die Erzeugungseinrichtung die Ausstoßspannung, die Elektrophoresespannung und die Rührspannung erzeugt und die Rührspannung vor der Erzeugung der Elektrophoresespannung und der Ausstoßspannung erzeugt wird.

8. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 7 beansprucht, bei der die

Rührspannung eine Gleichspannung mit der gleichen Polarität wie die geladenen Partikel ist.

9. Elektrostatische Tintenstrahl-Aufzeichnungsvorrichtung, wie in Anspruch 8 beansprucht, bei der die Rührspannung aus der Gleichspannung besteht, der eine Wechselspannung überlagert ist.

Revendications

1. Imprimante électrostatique à jet d'encre, comportant :

un corps de tête (1) ayant une chambre à encre (8 ou 80) pour renfermer une encre liquide contenant un matériau particulaire chargé,
un orifice d'éjection (3 ou 23) agencé au niveau d'une extrémité dudit corps de tête et connecté à ladite chambre à encre, pour éjecter l'encre liquide,
une électrode d'éjection (2) agencée à proximité dudit orifice d'éjection et alimentée par une tension d'éjection ayant la même polarité que la caractéristique de charge dudit matériau particulaire chargé, et
une contre-électrode (20) agencée à l'opposé dudit orifice d'éjection via un support d'impression et ayant un potentiel électrique nécessaire pour une attraction électrique dudit matériau particulaire chargé,

caractérisée par une paire d'électrodes d'agitation espacées verticalement (5A, 5B ou 15A, 15B ou 25A, 25B) agencées au niveau de la partie supérieure et de la partie inférieure de ladite chambre à encre et alimentées par une tension d'agitation pour déplacer ledit matériau particulaire chargé au moins dans la direction inverse à la direction de gravité, et

des moyens de génération de tension (30, 31, 32 et 9 ou 19) pour générer ladite tension d'éjection et ladite tension d'agitation, cette dernière étant générée avant la génération de ladite tension d'éjection.

2. Imprimante électrostatique à jet d'encre selon la revendication 1, dans laquelle lesdits moyens de génération de tension comportent des moyens de génération de tension d'éjection (32) pour générer ladite tension d'éjection et des moyens de génération de tension d'agitation (2 ou 19) pour générer ladite tension d'agitation, une desdites électrodes d'agitation étant en contact avec ladite encre liquide, et lesdits moyens de génération de tension d'agitation (9 ou 19) générant en tant que ladite tension d'agitation une tension en courant continu ayant la même polarité que ledit matériau particulaire chargé.

3. Imprimante électrostatique à jet d'encre selon la revendication 2, dans laquelle lesdits moyens de génération de tension d'agitation (9) génèrent une tension d'agitation constituée de ladite tension en courant continu sur laquelle est superposée une tension en courant alternatif.

4. Imprimante électrostatique à jet d'encre selon la revendication 2, dans laquelle ladite tension d'agitation est générée lorsque ladite tension d'éjection n'est pas générée.

5. Imprimante électrostatique à jet d'encre selon la revendication 1, dans laquelle lesdites électrodes d'agitation comportent une première électrode d'agitation (15B ou 25B) agencée au niveau de la partie inférieure de ladite chambre à encre et une seconde électrode d'agitation (15A ou 25A) agencée au niveau de la partie supérieure de celle-ci, et ladite première électrode d'agitation est agencée également sur le côté opposé à ladite direction d'éjection d'encre, et est alimentée par une tension d'agitation pour déplacer ledit matériau particulaire chargé dans la direction inverse à la direction de la gravité et dans ladite direction d'éjection d'encre.

6. Imprimante électrostatique à jet d'encre selon la revendication 5, dans laquelle la face de ladite chambre à encre (80) opposée audit orifice d'éjection (23) est inclinée par rapport à la direction de gravité.

7. Imprimante électrostatique à jet d'encre selon la revendication 1, dans laquelle :

une électrode électrophorétique (4) dans laquelle une tension électrophorétique est délivrée pour déplacer ledit matériau particulaire chargé vers ledit orifice d'éjection par électrophorèse est formée dans ledit corps de tête, et lesdits moyens de génération génèrent ladite tension d'éjection, ladite tension électrophorétique et ladite tension d'agitation, et ladite tension d'agitation est générée avant la génération de ladite tension électrophorétique et de ladite tension d'éjection.

8. Imprimante électrostatique à jet d'encre selon la revendication 7, dans laquelle ladite tension d'agitation est une tension en courant continu ayant la même polarité que ledit matériau particulaire chargé.

9. Imprimante électrostatique à jet d'encre selon la revendication 8, dans laquelle ladite tension d'agitation est constituée de ladite tension en courant continu sur laquelle est superposée une tension en courant alternatif.

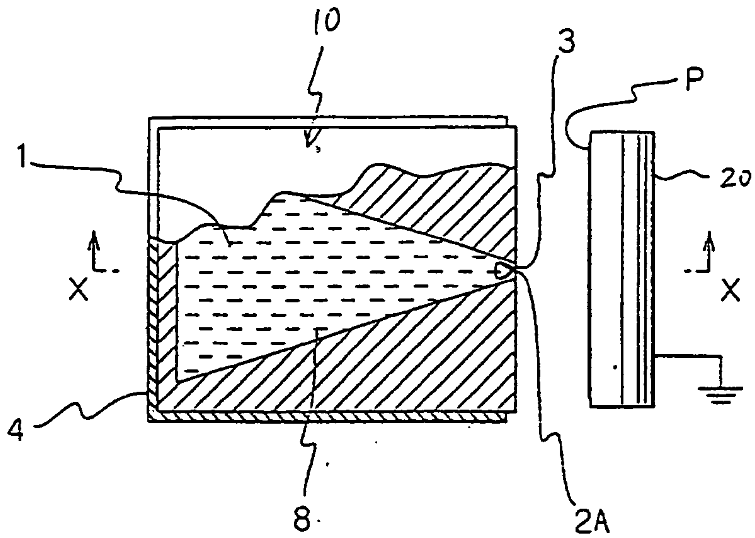

FIG. 1

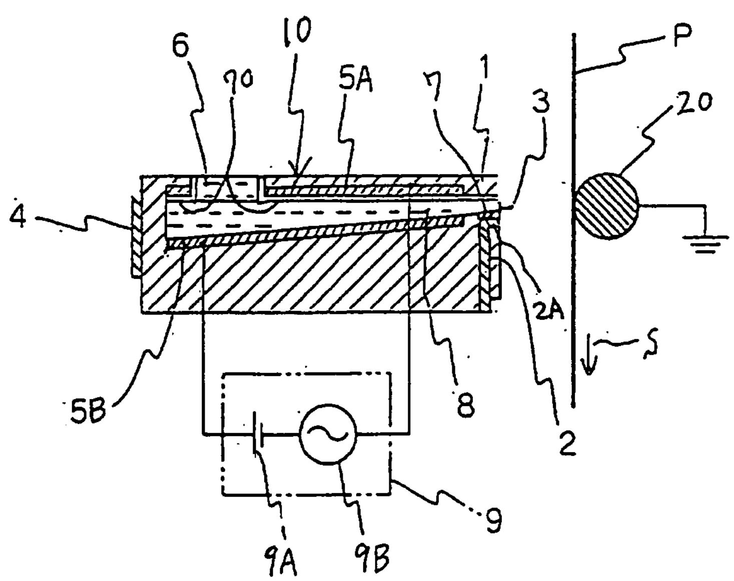

FIG. 2

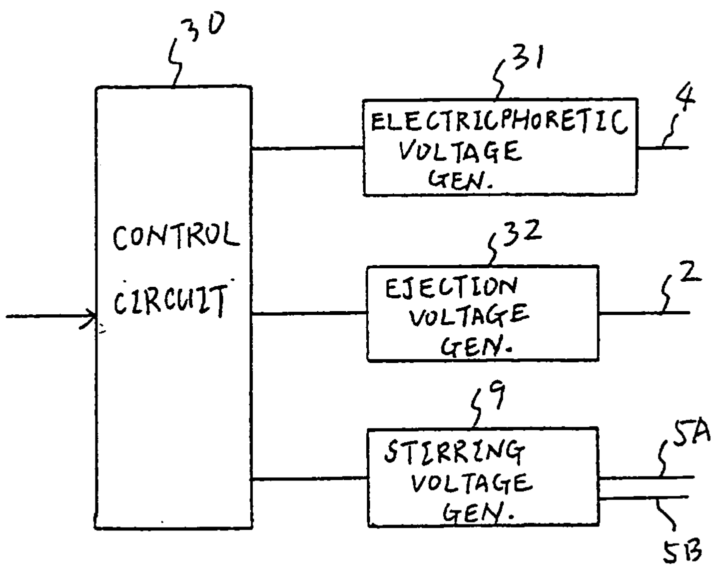
30
CONTROL
CIRCUIT
31
ELECTRICPHORETIC
VOLTAGE
GEN.
4
32
EJECTION
VOLTAGE
GEN.
2
9
STIRRING
VOLTAGE
GEN.
5A
5B

FIG. 3

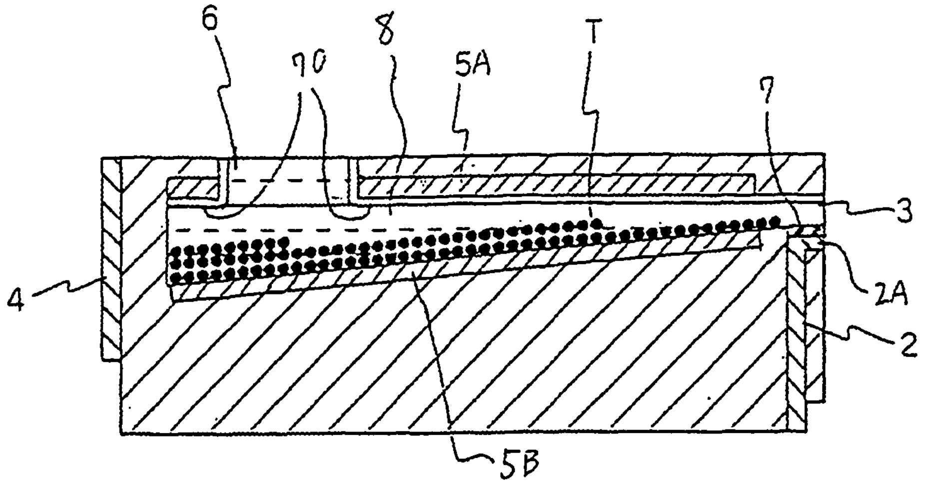

FIG. 4

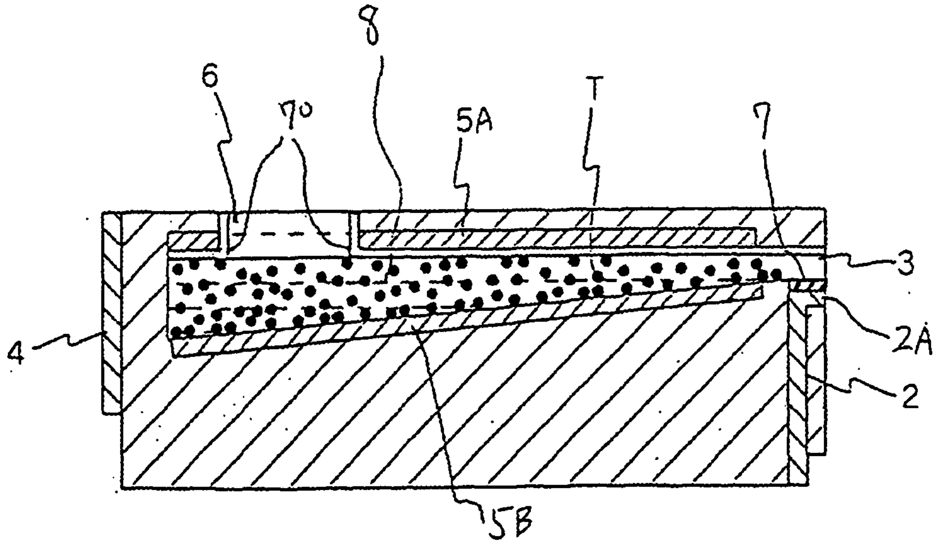

FIG. 5

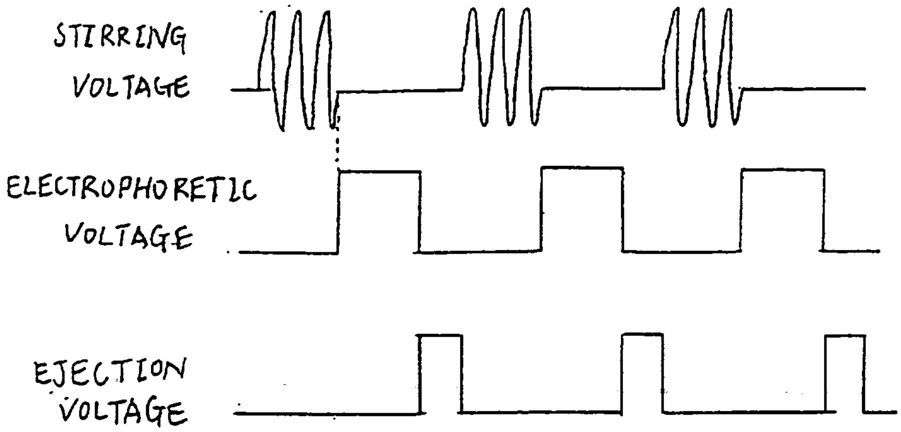
STIRRING VOLTAGE
ELECTROPHORETIC VOLTAGE
EJECTION VOLTAGE

FIG. 6

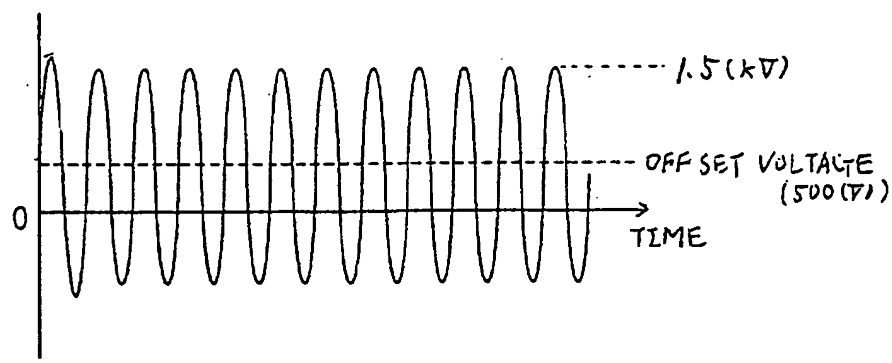
1.5 (kV)
OFF SET VOLTAGE (500 (V))
0
TIME

FIG. 7

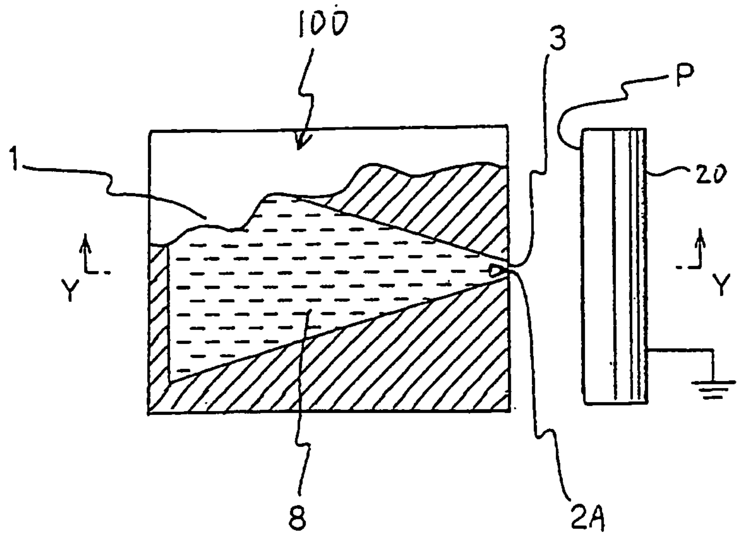

FIG. 8

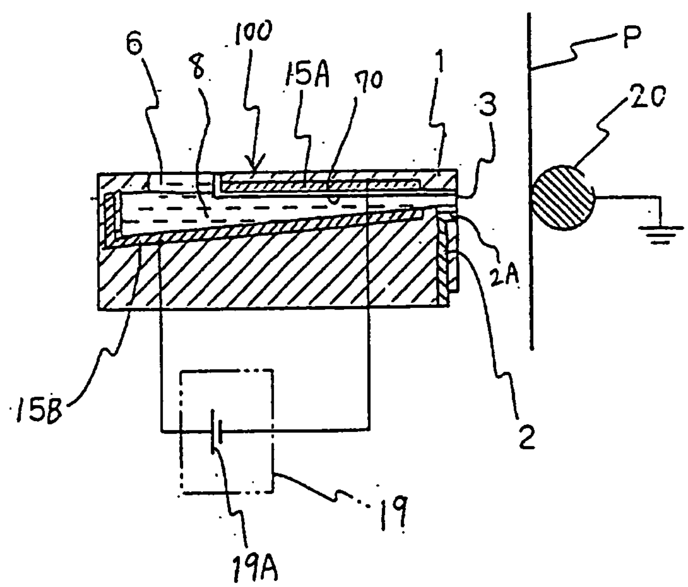

FIG. 9

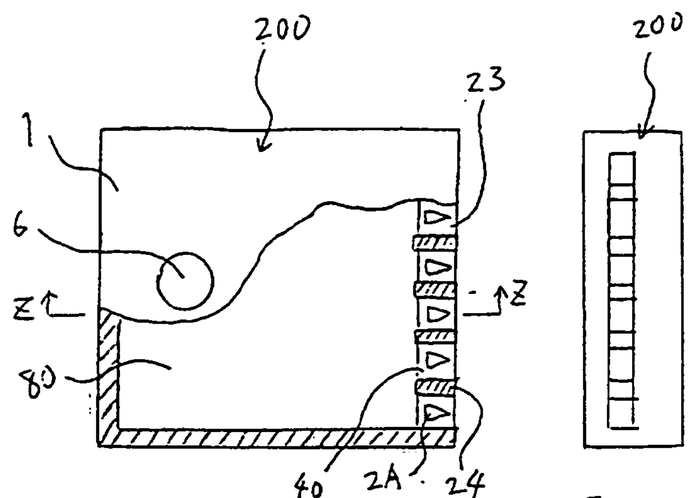

FIG. 10A

FIG. 10B

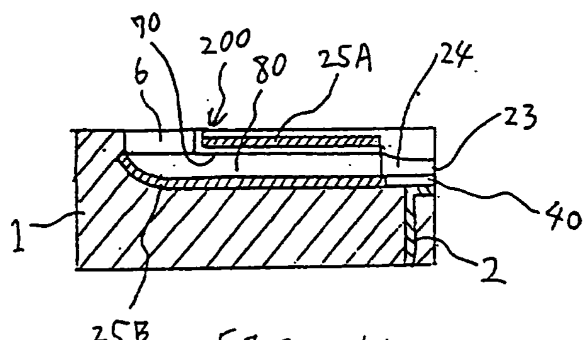

FIG. 11